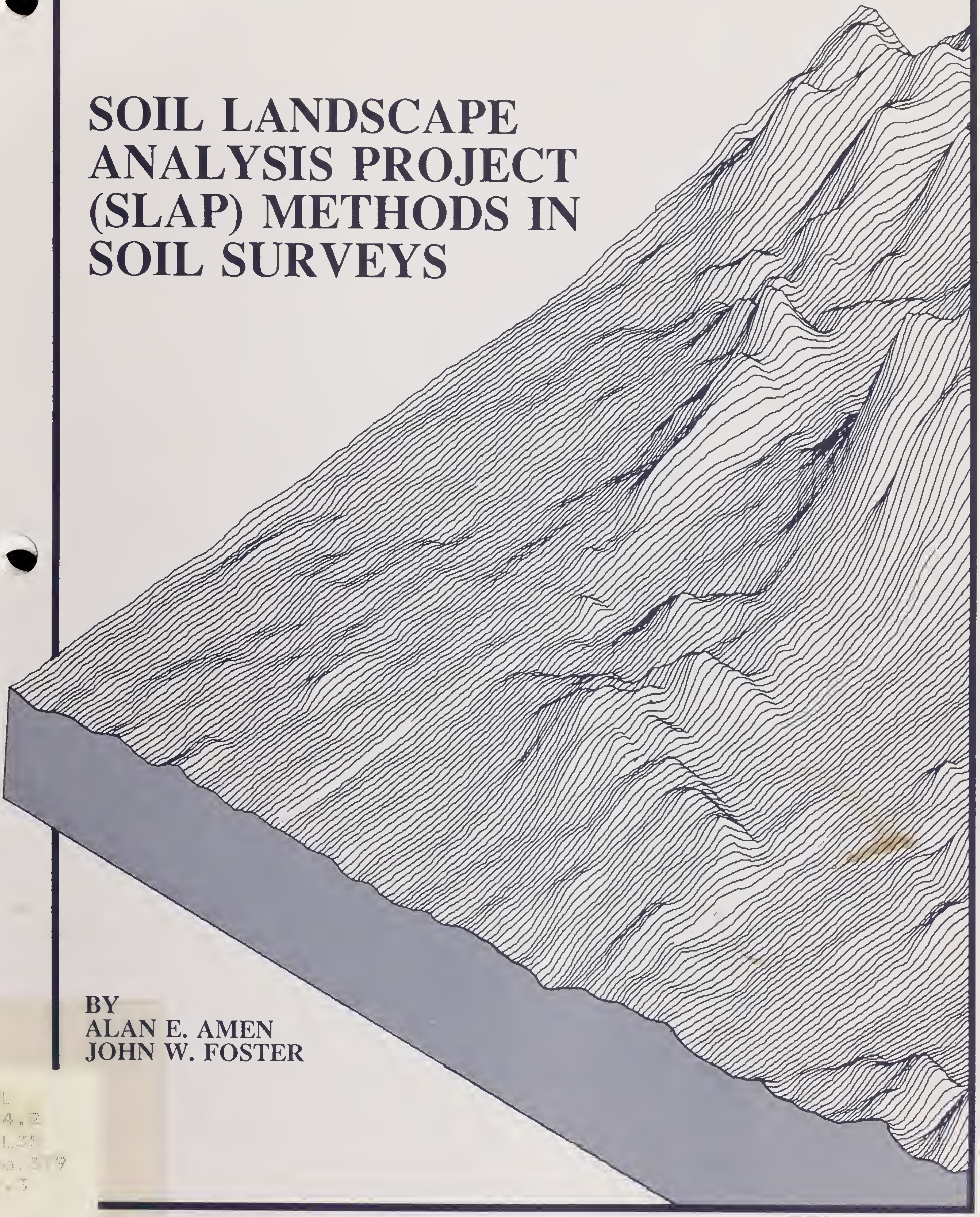
Technical Note 379

SOIL LANDSCAPE ANALYSIS PROJECT (SLAP) METHODS IN SOIL SURVEYS



BY
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BLM Technical Note 379

SOIL LANDSCAPE ANALYSIS PROJECT (SLAP) METHODS IN SOIL SURVEYS

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Service Center
Denver, CO

August 1987

BLM/YA/PT-87/016+7000

United States Department of the Interior
Bureau of Land Management

Available from:

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ACKNOWLEDGMENTS

The authors wish to express their gratitude to numerous individuals who participated in the development of the Soil Landscape Analysis Project (SLAP) methodology and this technical note. The coordination of three government agencies and a private consultant required exceptional professionalism to bring the SLAP methodology test to conclusion. Our thanks to John Fisher, SCS Soil Survey party leader and his staff; Emil Horvath and Eugene Fosnight, USGS EROS Data Center; Jerry Harmon, BLM, Soil Scientist; Bill Dollarhide, SCS Soil Correlator; James Stone, BLM, Washington Office Soil Scientist; Don Cain, BLM, Associate District Manager, Burns District; Albert Klingebiel, retired SCS, consultant; and the BLM Service Center support staff.

PREFACE

This technical note describes the Soil Landscape Analysis Project (SLAP) methodology for making Order 3 soil surveys and for supplementing and updating existing soil surveys. It is intended to inform and instruct soil scientists, resource managers, and soil survey users on the application and use of this methodology.

SLAP methodology incorporates Geographic Information System (GIS) technology, Digital Elevation Model (DEM) data, and Landsat Multispectral Scanner (MSS) data (when applicable) with the soil mapping process to create pre-maps and final soil maps with a digital data base. The process permits the use of GIS for edge matching soil polygons, calculating area, manipulating tabular data, and generating thematic maps. SLAP methodology can be used to make new soil surveys, supplement and update existing soil surveys, and extrapolate sample site information to larger areas.

This technical note is based mainly on experiences gained from the Tonopah, Nevada, Pilot Test conducted from 1983 to 1985. It includes an evaluation summary and application opportunities of the SLAP methodology, descriptions and use of products generated from DEM and MSS data used in mapping soils, and recommended procedures and techniques.

Additional information can be obtained from the Bureau of Land Management Service Center; Division of Resources (D-470); Box 25047; Denver, CO 80225-0047; FTS 766-0154 or Commercial (303) 236-0154.

INTRODUCTION

Soils information is essential in managing public lands and monitoring renewable resources. The Soil Landscape Analysis Project (SLAP) methodology was developed by three federal agencies to enhance soil survey mapping procedures, improve the accuracy of soil survey, make soil scientists' field time more efficient, and assist in creating a digital soil data base. The U.S. Department of the Interior, Bureau of Land Management (BLM) and U.S. Department of Agriculture, Soil Conservation Service (SCS) in cooperation with the U.S. Department of the Interior, U.S. Geological Survey (USGS), Earth Resources Observation Systems (EROS) Data Center have jointly tested and evaluated the application of SLAP methodology in making soil surveys and creating an accompanying digital soil data base.

The SLAP concept was initially tested in the Grass Creek Resource Area in the Big Horn Basin of Wyoming in 1982. To further define procedures, they also conducted a second test in the Soda Springs Resource Area, Idaho, in 1983. These two tests resulted in a full scale implementation study conducted near Tonopah, Nevada, in Fiscal Years 1983 through 1985. The Tonopah SLAP test area encompassed 25, 7.5-minute USGS quadrangles covering a total of 936,000 acres. The Tonopah test results and related experiences indicate that SLAP methodology can be used successfully to make new soil surveys, to supplement and update existing soil surveys, and to extrapolate soil map unit delineations and related soil information from selected sample sites.

SLAP methodology incorporates computer-generated slope, aspect, spectral maps, and statistical summaries to assist throughout the soil mapping process resulting in an edited and verified digital data layer that is part of the Geographic Information System (GIS) data base. The soil map produced with the aid of these methods conforms to the standards and criteria of the National Cooperative Soil Survey (NCSS).

EVALUATION SUMMARY

The purpose of the computer-assisted methodology is to incorporate GIS technology, DEM data, and Landsat MSS data (where applicable) into a computer information base that can more efficiently and economically develop Order 3 soil surveys for managing public lands and monitoring renewable resources. This methodology is intended to increase the accuracy of soil surveys and to reduce the time needed for field mapping. The data base generated through the computer-assisted methodology can also aid in the ongoing assessment and management of rangeland resources.

The large size, difficult access, and rough terrain of rangeland areas necessitate an efficient, low-cost method of classifying and mapping soils. Based on field tests, this methodology provides useful information that facilitates the mapping process. Information and technology provided by the computer-assisted methodology can also be used effectively to update old soil surveys and to supplement existing Order 3 soil surveys.

Field members who have used the methodology and others who have been associated with the project have made the following application recommendations and evaluations of the computer-assisted methodology.

Application Recommendations

- SLAP methodology is especially effective in areas where access is difficult or limited to formulate a pre-map and to identify more representative areas to sample, thus reducing time spent in the field.

- Soil scientists can use SLAP methodology to predict soil boundaries and to identify kinds of soil for lower-intensity rangeland surveys, where mapping units commonly are soil associations.

- The methodology can be used to supplement and update existing soil surveys. Soil boundaries can be refined and additional information, such as slope, can be provided. Supplemental mapping may involve subdivisions of larger map units by addition of finer slope classes.

- Soil survey information can be extrapolated from soil surveys of key representative areas and extended effectively by use of products generated from DEM data. By sampling key areas modeled with DEM data, soil survey information may be extrapolated and extended throughout the soil area.

- The methodology provides a soil digital thematic layer that is incorporated into the GIS data base for soil interpretation analysis which is useful for ongoing resource management.

Evaluation of Methodology

- The methodology is versatile and can be modified or tailored. Portions or combinations of procedures can be used to meet the specific needs of soil survey areas.

- The slope map generated from DEM data is one of the most effective products in mapping soils. Since topography is one of the important factors in soil formation, use, and management, slope-class maps generated from DEM data provide a good physiographic base for identifying soil delineations. Slope-class maps can also be used effectively in conjunction with aerial photographic interpretation (stereoscopy) to identify slope gradients.

- The methodology assists in designing soil map units to be compatible with the landscape and to meet major user needs. Related resource data are incorporated into the generation of the pre-map. The statistical summaries are helpful in describing occurrence and extent of soil components and inclusions within a soil map unit.

- The methodology emphasizes soil formation processes and provides a soil mapping model that relates soils to landscape. The Tonopah test indicates the degree of correlation (soils to landscape and geomorphic processes) allows inferences and prediction of soils.

- Since many soil boundaries coincide with observable features of the landscape, soil delineations can be easily and accurately extended by direct field observations. Although this can be done on the ground, it can usually be done more rapidly and accurately by using SLAP methodology that emphasizes the use of DEM data in relationship with geomorphic modeling.

- Although specific soil series and phases can be identified only with field work, the methodology allows certain phases to be mapped with a minimum of field checking.

- The methodology provides a good quality control and training tool for soil surveys. Inexperienced soil scientists can easily and effectively grasp concepts of soil mapping by using the pre-map methodology.

- The field portion of soil mapping will not be replaced. However, by using SLAP methodology, the field staff can reduce field time and use it more effectively to inventory and interpret soils. The pre-mapping techniques also improve the accuracy of soil surveys. Development of the soil pre-map can be accomplished during inclement weather, allowing more effective use of field time during favorable weather.

THE SOIL MAPPING PROCESS AND SLAP METHODOLOGY

In essence, soil mapping is an integrated expression of the geologic (soil parent material), geomorphologic, soil, vegetative, and climatic conditions of an area. The soil mapping procedure generally involves the following three main processes as shown in the data flow diagram (Figure 1).

- **Develop Map Unit Hypothesis (Soil Pre-map Preparation).** Collect and interpret existing resource data (e.g., soils, geology, vegetation, climate, land use) in conjunction with a field reconnaissance to formulate a hypothesis of the kind and location of soils in the area to be mapped.

- **Test Hypothesis (Field Verification).** Select and use methods (soil pits, traverses, and transects) when making field observations to verify the kind and location of soils in the area being mapped. Type of observation depends on the soils and intended use of soil maps.

- **Record Soil Delineations.** Refine and record soil map unit delineations and identification symbols on an appropriate mapping base including computer storage. Placement of lines is guided by such methods as stereoscopy; aerial photographic interpretation; use of computer-generated slope, aspect, and spectral maps--all based on soil sampling and field observations.

SLAP methodology follows the systematic approach of the soil mapping procedure as outlined by the National Cooperative Soil Survey (NCSS) program.

The soil mapping process can be greatly facilitated through the use of computer-assisted soil mapping (soil modeling). Development of the map unit hypothesis is essentially the soil pre-map process of SLAP methodology that includes:

- collecting and using existing soil resource information relating to soil-forming factors (climate, vegetation, topography, and parent material geology) that influence soil characteristics;

- interpreting aerial photographs (stereoscopic aerial photography coverage and orthophotographs);

- interpreting slope and aspect maps generated from DEM data;

- plotting soil map unit delineations;

- selecting sample sites and planning field itineraries.

The field observation and verification phase includes the process of testing the soil pre-map hypothesis and completing soil sampling and identification. During the field verification phase, soil pre-map delineations are reviewed, refined as necessary, and recorded. Soil map units are then described to accommodate the needs of users and to provide accurate interpretations.

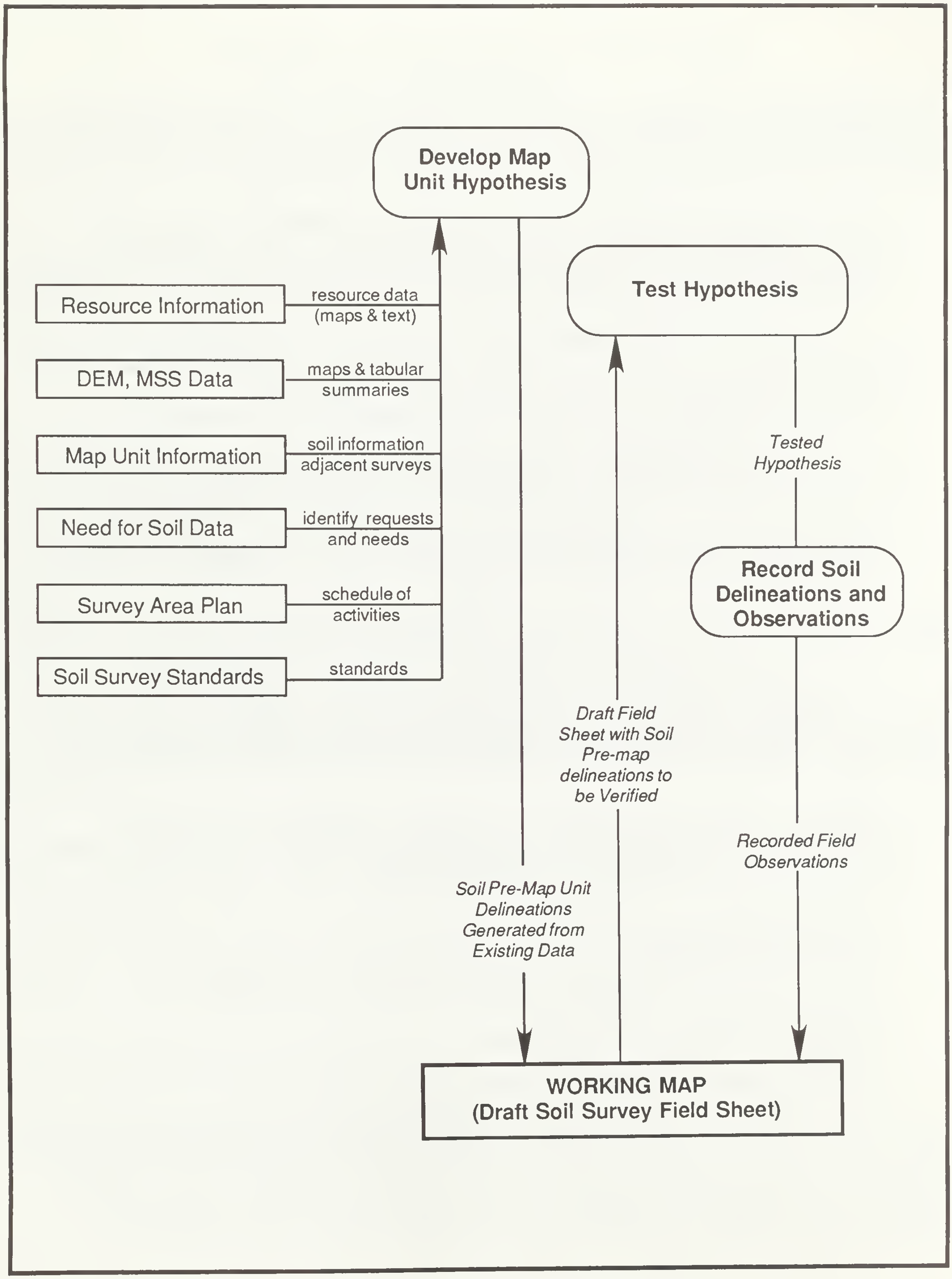


Figure 1. Data flow diagram showing soil mapping process.

DEM AND MSS PRODUCTS USED IN SOIL MAPPING

Products produced from DEM and MSS (Landsat) data for use in SLAP methodology are slope-class maps, aspect-class maps, spectral-class maps, and accompanying statistical summaries. Elevation-class contours and perspective plots can also be prepared from digital elevation data, but were not used in the Tonopah test. DEM products used for soil mapping are produced from 7.5-minute DEM data. The DEMs are created by using digitizing orthophoto equipment or contour digitizing and profiling techniques. DEMs consist of elevation values spaced in regular 30-meter intervals. The values are expressed in meters and referenced to the Universal Transverse Mercator (UTM) coordinate system. The 7.5-minute DEMs have 1- to 7-meter vertical accuracy.

The following is a brief description of each product, its applications and limitations. For more information on these products and their specifications, see Definition of U.S. Geodata Products for Use in Soil Surveys (USGS 1986).

Slope-Class Maps

Slope-class maps (Figure 2) are produced on transparent mylars at a scale of 1:24,000 with the various slope classes shown in color. Slope root-mean-square calculations are derived from the elevation values of DEM data and then grouped according to the slope classes (categories) desired by the field. The slope classes used will vary depending on the terrain, land use, and soil interpretation needs of the area. Slope classes selected for the Tonopah test were: (a) 0 to 2%, (b) 3 to 8%, (c) 9 to 15%, (d) 16 to 30%, (e) 31 to 50%, and (f) 51% or more. The images that contain continuous values for percent slope become part of the spatial data base as do the images of grouped slope classes.

The digital slope-class map can be filtered to eliminate areas that may constitute unwanted detail or noise. Area filtering is a procedure whereby an image is first converted from grid-cell format to polygon by outlining all similar grid cells that occur in groups. Then a minimum-sized area is chosen, and all polygons smaller than that are eliminated. The resulting void is filled with information equal to the background.

Slope maps are used to identify degree of slope for landscapes or polygons delineated during the soil pre-map generation process. Test results indicate slope maps are accurate and reliable for areas where slopes are greater than 5 percent slope. Slope maps are less reliable in areas with slopes of 0 to 5 percent. Thus, to separate nearly level to gently sloping floodplain areas from gently sloping (less than 5 percent) adjoining side slopes or upland areas would require additional aerial photographic (geomorphological) interpretation.

Use of slope-class maps is similar to use of stereoscopic aerial photographic interpretation to delineate areas of similar slope. In addition to identifying delineations, the slope gradient percentage is also determined.

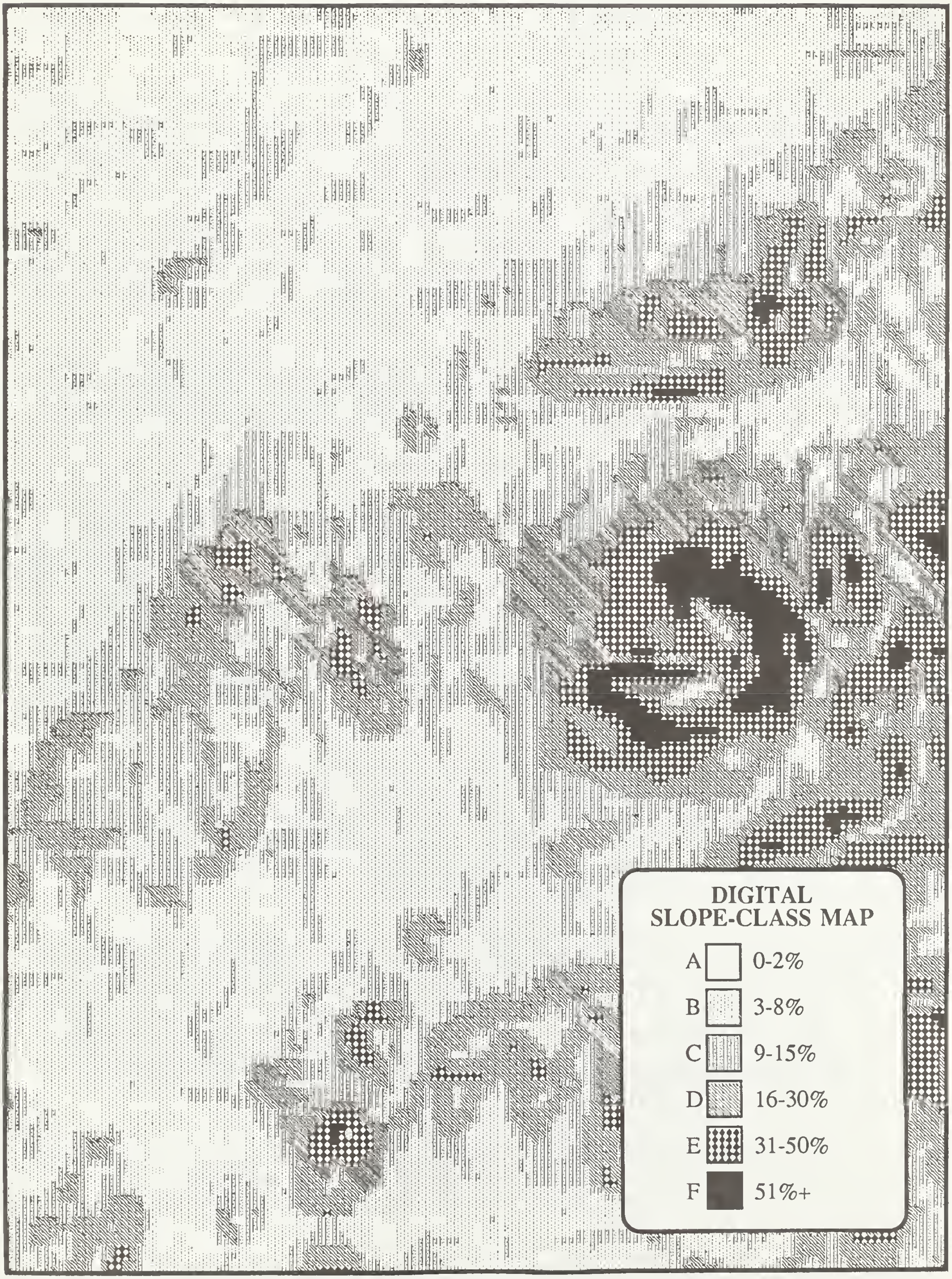


Figure 2. Digital slope-class map (Scale 1:24,000) showing slope classes. NW part of Belle Helen, Nevada, quadrangle.

Topography is an important factor in soil formation and in soil use and management. Slope-class maps, in conjunction with aerial photographic interpretation, are effective tools in preparing physiographic maps and provide the basis for potential soil map unit delineations.

Aspect-Class Maps

Aspect-class maps (Figure 3) are developed from root-mean-square calculations derived from the elevation values of DEM data. These are then grouped according to the classes determined by field soil scientists. The aspect classes used will vary depending on the terrain and potential use of the area. Most commonly, four classes (north, south, east, and west) are used. Aspect classes are described in degrees of the compass. The aspect-class images are reproduced on transparent mylar at a scale of 1:24,000 with classes differentiated by colors. Aspect-class maps are used as overlays to the slope-class and orthophoto map during the soil pre-map development.

Aspect maps are effective tools for mapping soils and vegetation in areas where aspect influences soil formation, soil temperature and moisture conditions, and the type of vegetation. In areas of low precipitation (usually less than 6 inches annually) and with slope less than 15 percent where aspect does not influence soil formation or cause significant vegetation change or management need, aspect maps would not be used.

Elevation-Class Contours

Elevation-class contours can also be developed from elevation values contained in DEM data. Elevation-class lines are identified most commonly on aspect-class and slope-class maps.

Elevation-class contours are useful in mapping areas where elevation changes affect soil temperature, soil moisture, vegetation, and land use.

Perspective Plots

Perspective plots are three-dimensional terrain models generated from DEM data. For the most part, maps have been relied on to convey soil survey information; however, maps are only two-dimensional. Because perspective plots are three-dimensional, they provide an effective means of displaying and communicating soil survey information to users.

An example of a perspective plot is shown on the cover of this technical note. This plot shows the terrain of a portion of the sample area (northwest corner of the Belle Helen, NV Quadrangle) that has been used throughout this document to display other DEM products. The view of this perspective plot is from the southwest at a 30° altitude angle with vertical exaggeration of 3 to 1.

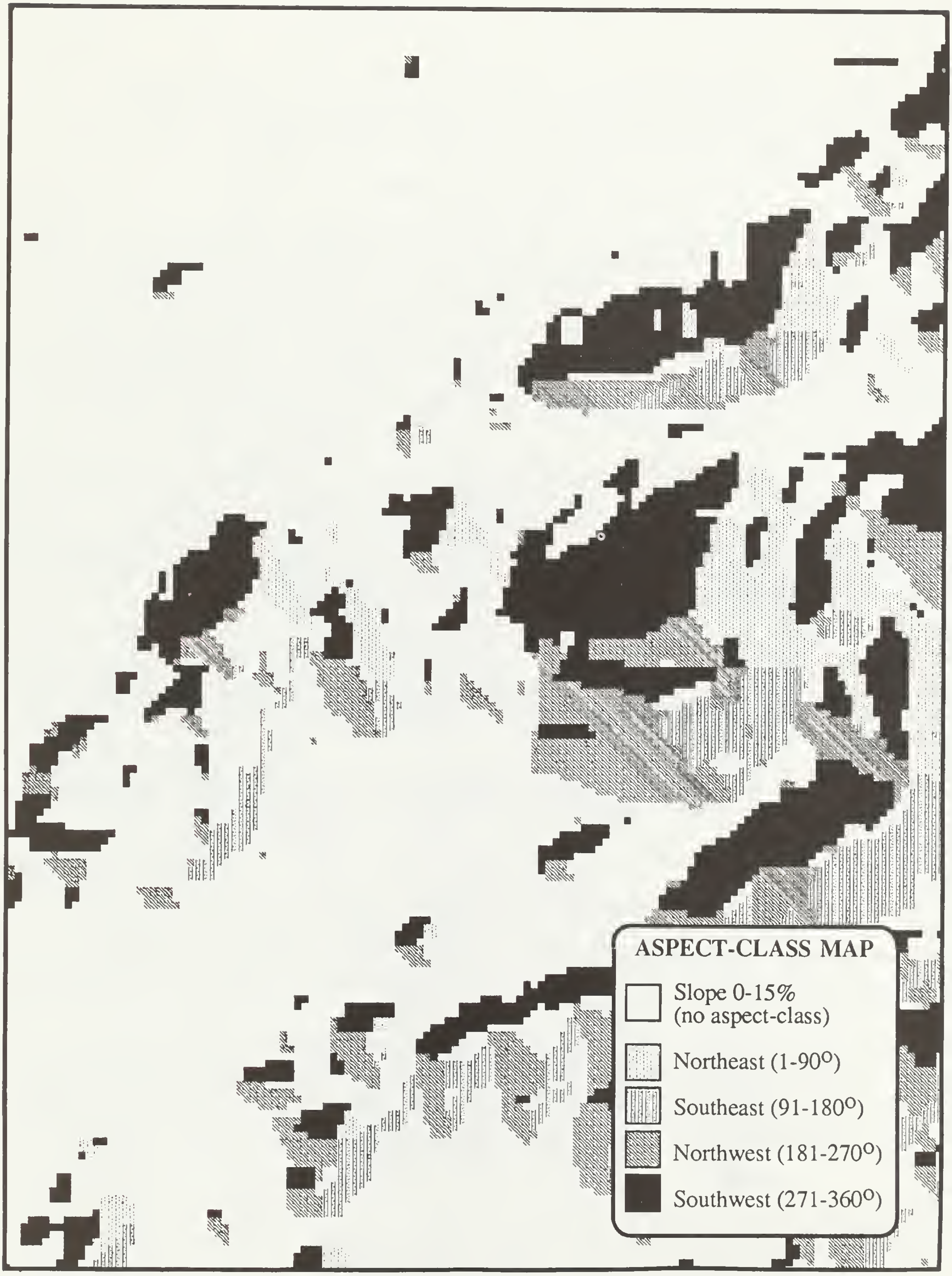


Figure 3. Computer-generated aspect-class map (Scale 1:24,000). NW part of Belle Helen, Nevada, quadrangle.

Spectral-Class Maps

Spectral-class maps (Figure 4) are created from Landsat MSS data that have been registered to geographic coordinates and then stratified using standard image-clustering and classification techniques to derive surface land cover types. The spectral classes represent surface reflectance that has been statistically sampled into similar groupings that are influenced by the interaction of vegetation, soils, surface moisture, and roughness. These data are resampled into 30-meter grid cells and then subsectioned and mapped onto 1:24,000-scale, color-coded, clear mylar overlays coinciding with orthophotograph quadrangles. The spectral data are geometrically corrected and registered to the 7.5-minute digital elevation model data.

Spectral-class maps are used mainly during field verification to identify spatial and spectral variability within the pre-map delineations. Experiences in the Tonopah test area indicate spectral-class maps were not effective as a mapping tool in areas with less than 20 percent vegetation cover. The use of spectral maps may not be practical in some soil surveys because of the cost and the limited benefits derived from them.

Additional information on the use of spectral data in soil survey is available at the Division of Resources, BLM Service Center.

Tabular Summaries

Tabular summaries (Figures 5 and 6) can be produced for the filtered slope-class map, soil pre-map delineations (where the pre-map is digitized), and for the final soil map unit delineations. These summaries are generated from DEM data and MSS data (where used) for each polygon, by quadrangle, and list information such as soil polygon number, soil map unit number, elevation (minimum and maximum), slope (percent of polygon and acres by slope class), aspect (percent of polygon and acres by aspect class), total acreage within each polygon, slope class symbol, and landform symbol. The statistical information listed in the tabular summaries will vary according to soil survey area needs and can be determined by the field staff.

Experiences from the Tonopah test revealed that, where too much information was listed, the summaries were less useful. Therefore, it is recommended that only key information such as elevation (minimum and maximum), slope percentages of dominant and secondary slope classes occurring within each polygon, and total acreage of polygon should be listed.

Tabular summary data are valuable in preparing soil map unit descriptions as well as providing additional information to soil map users. The extent, occurrence, and location of soil map unit components can be more accurately identified and described from the information provided by the summaries. The Tonopah test experiences indicate these summaries were more useful when provided after the pre-map is verified to describe the soil map unit and accompanying inclusions.

Figure 4. Spectral-class map, generated from Landsat imagery (Scale 1:24,000). NW part of Belle Helen, Nevada, quadrangle.

BELLE HELEN
STATISTICAL SUMMARY BY SOIL POLYGON NUMBER

	SLOPE						ASPECT				ELEV.	
Soil Pol Num	Dom Cls	Dom Area	Sec Cls	Sec Area	Avg %	Mod %	Dom	Dom Area	Sec	Sec Area	Min Ft	Max Ft
1	BC	69	D	21	7	5	NW	71	SW	21	5972	6562
2	E	39	D	29	21	11	NW	40	SW	35	6160	7475
3	E	38	F	25	25	20	SE	28	NE	28	5972	7743
4	F	37	E	27	23	9	NW	59	NE	23	5972	6133
5	BC	63	D	26	8	5	NW	60	SW	38	6079	6401
6	BC	67	D	20	7	6	SW	39	NW	37	6160	6723
7	BC	43	D	42	11	8	NW	55	SW	34	6401	6562
8	D	40	BC	36	11	3	NW	45	NE	36	6267	6455
9	BC	59	D	31	8	6	NW	77	SW	18	6294	6455
10	D	41	BC	30	11	3	NE	43	NW	37	6428	6535
11	BC	71	D	22	7	6	NE	53	SE	22	6535	6562
12	D	52	BC	32	11	12	NE	70	NW	22	6589	6723
13	E	38	D	30	15	6	NW	43	NE	35	6186	6965
14	BC	40	D	35	10	3	NW	30	SW	27	6670	6911
15	F	48	E	24	38	27	NE	51	NW	36	6804	8065
16	E	42	D	37	19	14	NW	50	NE	46	8146	8414
17	G	35	F	33	43	40	NE	31	NW	30	6401	9327
18	E	41	F	24	24	18	NE	29	NW	28	8602	9219
19	E	44	D	27	14	17	SE	57	NE	22	6294	6428
20	D	41	BC	40	10	8	SE	51	NE	46	6133	6562
21	D	48	BC	40	9	10	NE	57	NW	38	6482	6884

Figure 5. Terrain statistics for Belle Helen, Nevada, quadrangle.

BELLE HELEN
STATISTICAL SUMMARY BY SOIL POLYGON NUMBER

*** MAP UNIT NUMBER AND SPECTRAL DATA ***

Soil Pol Num	Mun	Brt Mean	Grn Mean	Dominant		Secondary		Total Acres
				Class	Pcnt	Class	Pcnt	
1	3130A	64	37	14	87	12	12	1263
2	3223B	63	38	14	55	12	41	2761
3	3226B	52	34	12	54	14	13	19007
4	3631B	68	37	14	100	J	0	16
5	3134B	65	39	14	97	12	3	396
6	3481B	63	36	14	51	12	46	1500
7	3223C	64	37	14	78	12	22	41
8	3223C	60	34	12	63	14	21	73
9	3223C	61	34	12	66	14	28	32
10	3223C	63	36	12	60	14	40	20
11	3223C	65	38	14	82	12	18	11
12	3223C	62	36	12	48	14	47	60
13	3223B	63	37	14	54	12	43	701
14	3412B	54	33	12	83	11	11	142
15	3430B	45	34	12	45	6	42	735
16	3541D	39	37	6	68	2	27	41
17	3420B	38	33	6	40	3	23	8324
18	3541B	40	31	6	38	4	19	730
19	3420B	54	34	12	84	11	13	32
20	3465B	53	33	12	79	11	14	1396
21	3462C	57	34	12	84	13	8	291

Figure 6. Spectral statistics for Belle Helen, Nevada, quadrangle.

METHODOLOGY

This section describes the methodology developed for the Tonopah test and incorporates refinements and options suggested by field personnel and other specialists who have used and evaluated the methodology. A general flow chart of the complete SLAP methodology is shown in Figure 7.

The area located in the northwest portion of the Belle Helen, Nevada, quadrangle (Figure 8) is used as a sample site to show examples of DEM products and the SLAP methodology.

The methodology used to assist in the soil mapping process and to create the accompanying soil data base involves the following steps: (1) Adjust Slope-Class Map, (2) Make Soil Pre-Map, (3) Digitize Soil Pre-Map and Generate Digital Data Base (Optional), (4) Verify and Edit Pre-Map, and (5) Complete and Digitize Final Soil Map.

Adjust Slope-Class Map

The slope-class map generated from DEM data is adjusted to the USGS Quadrangle and orthophotograph by overlaying it with the topographic map and adjusting it to contour lines and landform units. During this process, the slope-class map is tailored to the survey area needs and unnecessary detail is eliminated. The adjusted lines are traced on clear mylar or on the slope-class map. An option is to overlay a half-tone orthophotograph mylar over the slope-class map and make adjustments based on aerial photographic interpretations. The orthophotograph mylar becomes the base field sheet (working map) with lines drawn directly on the frosted side in pencil so that lines can be erased and adjusted as necessary later during the field verification process. See Figure 9 for slope-class map with adjusted slope-class boundaries.

Make Soil Pre-Map

This process involves the development of soil map unit delineations by incorporating and interpreting information from computer-generated DEM products, other existing resource data, and aerial photograph interpretation.

At this point, map units are designed to meet the needs of major users and tailored to the survey area landscape. Involvement of other disciplines and soil survey users is helpful in determining map unit design.

Prior to the soil pre-map preparation, a field reconnaissance, including involvement of related disciplines and soil map users, is helpful to assure a complete understanding of the landscape, soil parent materials, land use, and vegetation within the area being mapped.

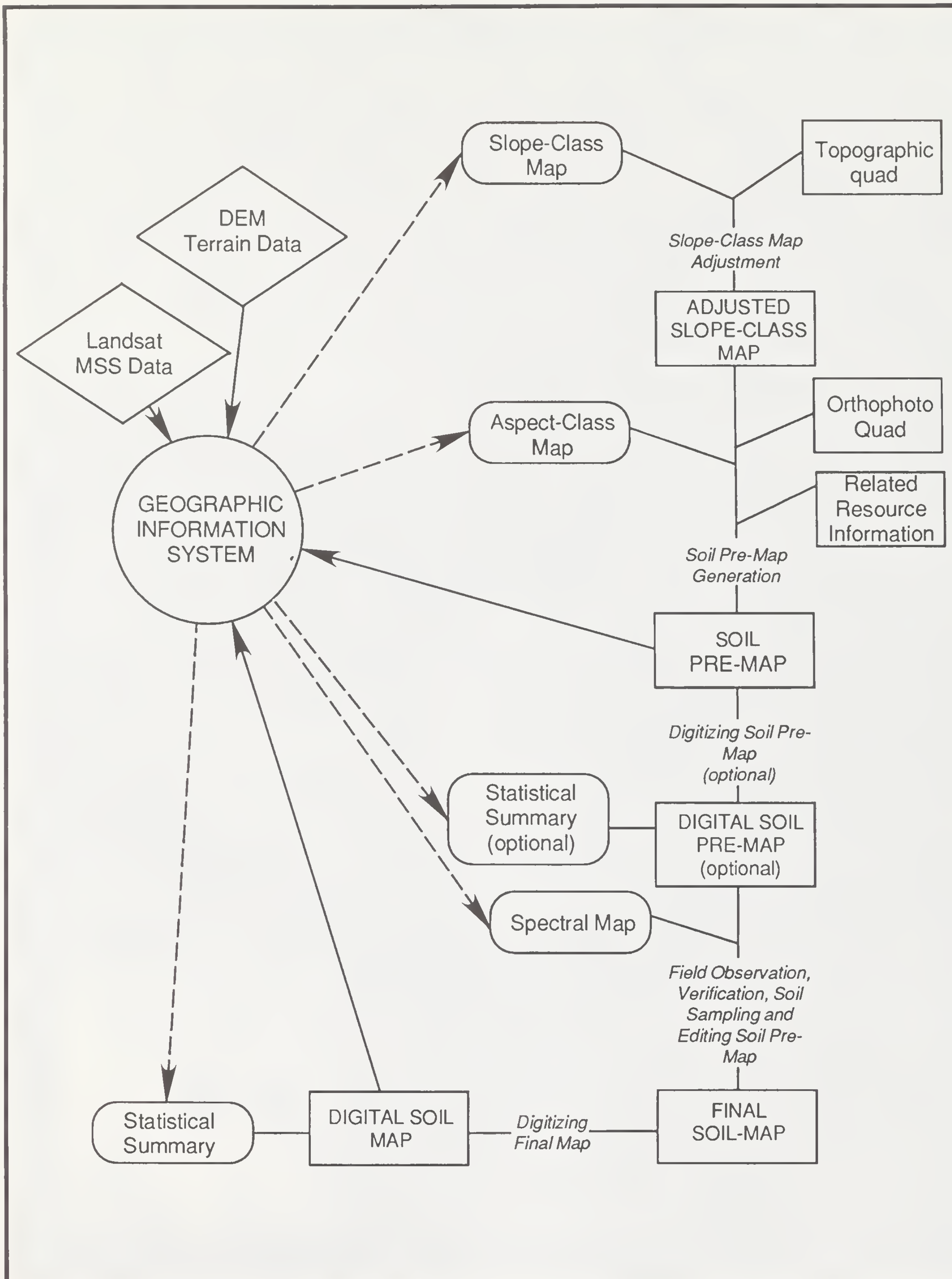


Figure 7. General flow chart showing complete SLAP methodology for mapping soils and creating an accompanying digital soil data base.

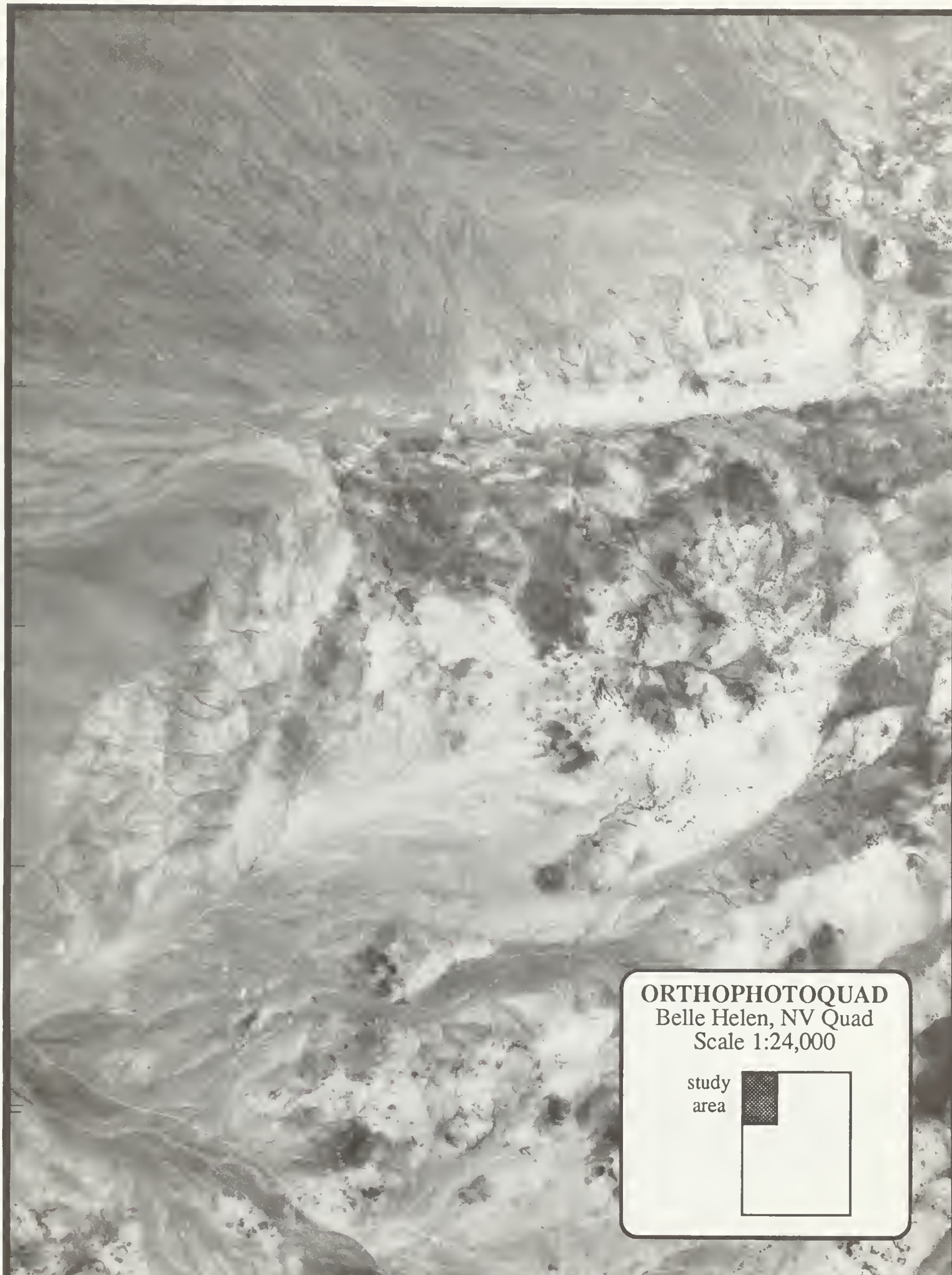


Figure 8. Orthophotograph of sample area (NW part of Belle Helen, Nevada, quadrangle) used to show computer-assisted methodology (Scale 1:24,000).

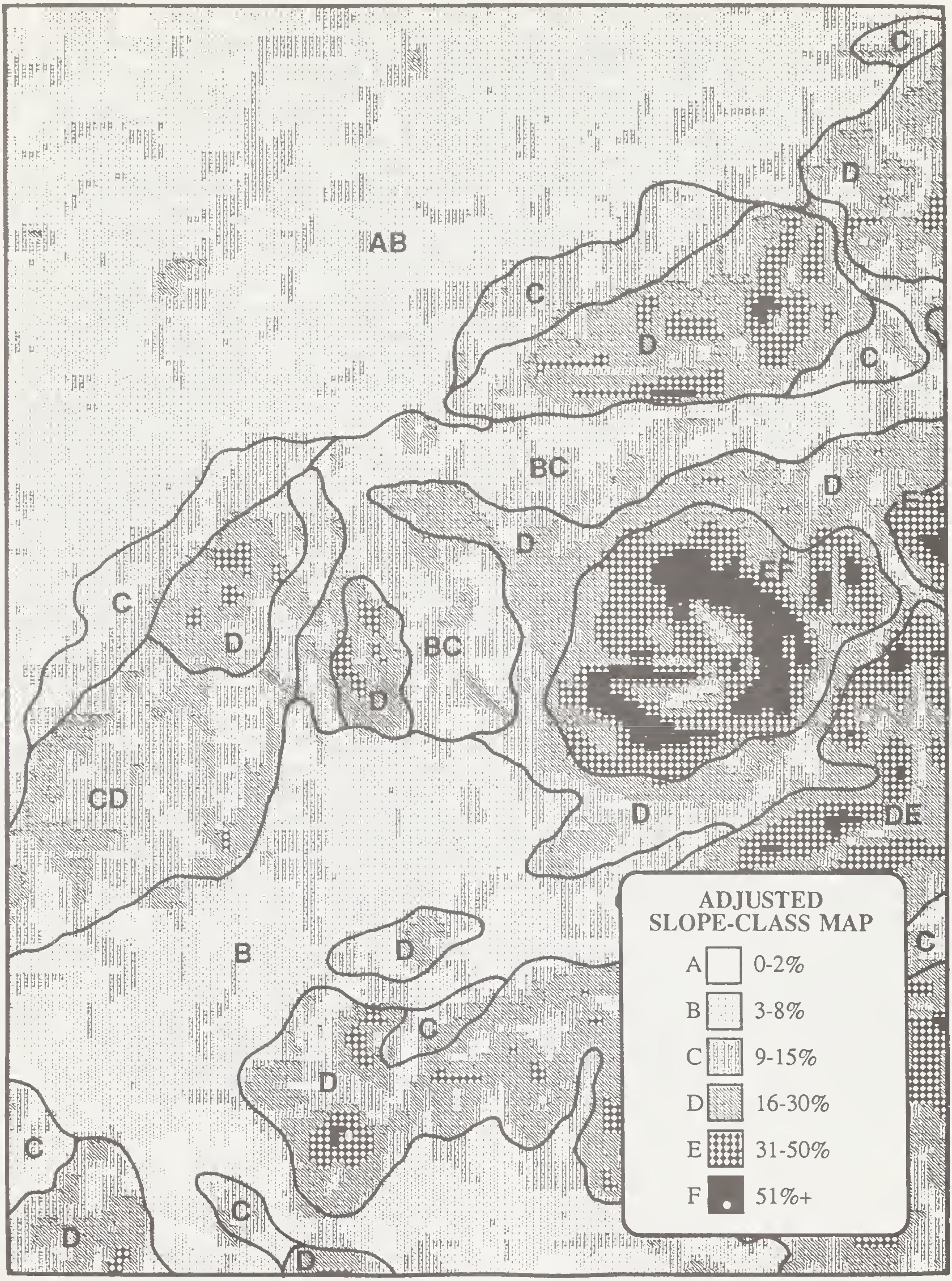


Figure 9. Slope-class map with slope-class boundaries adjusted to terrain on topographic map and orthophotograph.

The soil pre-map process begins with the adjusted slope-class map overlaid on an orthophoto quadrangle; soil delineations are developed on the basis of orthophotographic image interpretation with the slope-class map. During this process vegetative, climatic, geologic, and other related resource data for the area are also interpreted to provide soil setting, surface features, and soil property information (see Figure 10). Aerial photographic interpretations, including stereoscopic interpretations, are also made at this time with lines transferred to the orthophoto (soil base map) so that all information for the spatial data base is on the same scale and map projection.

During the soil pre-map phase, the pattern of soil occurrence and relationship to landscape is emphasized. The slope-class map, aspect-class map (where applicable), vegetation types, climatic information, and geologic information (soil parent material) are incorporated into a composite model to delineate landform based units. The soil map unit delineations at this point are defined mainly on the basis of geologic (parent material), geomorphic, and climatic soil forming factors.

The pre-map delineations and accompanying identification symbols are recorded on a clear mylar that is overlaid on the orthophotograph. Another option is to record pre-map delineations on a half-tone orthophotograph mylar or on the orthophotograph and use it as the base map as suggested in the slope-class map adjustment process. (See Figure 11 for example of soil pre-map.) Recording pre-map delineations and accompanying identification symbols on either a half-tone orthophotograph mylar or directly on to the orthophotograph provides an effective base map for field verification and soil sampling because it reduces the need to carry additional maps and mylar overlay maps during the field verification process.

An accompanying pre-map soil identification and descriptive legend is then developed for field staff review during field verification and soil sampling. This legend includes map unit symbol; setting information (landform, slope, vegetative, and climatic information); and general soil properties that can be inferred from resource data interpreted during the soil pre-map process and field reconnaissance. The soil pre-map units would be assigned names based on landform, slope class, and estimated classification at the lowest soil taxonomy level possible.

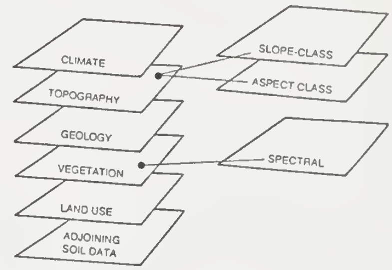
Digitize Soil Pre-Map and Generate Tabular Summaries (Optional)

The soil pre-map is then digitized and incorporated with the digital data base to create statistical summary data for the pre-mapped polygons to provide slope, aspect, and acreage calculations. This step is optional at this point. Digitizing can be bypassed until after the field verification phase.

SOIL MODELING AND MAPPING

Data Used

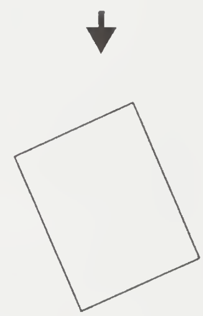
- Climate reports and maps
- Topography information of slope, aspect, elevation (DEM data)
- Geologic information (soil parent materials) and geomorphic processes
- Vegetation types (Landsat maps)
- Land use
- Existing soil information
- Aerial photos



Process

► **SOIL PRE-MAP PREPARATION**

- Composite resource information by overlay process
- Extrapolate soil information from selected mapped areas and existing soil data
- Delineate map units
- Map unit design (based on need and land use)
- Stereoscopic interpretations



SOIL PRE-MAP
(Ortho photo 1 24,000)

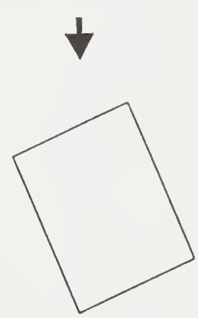
► **FIELD VERIFICATION AND PRE-MAP REFINEMENT**

- Field observations and sampling
- Refine delineations
- Identify soils
- Record field notes
- Complete soil map unit descriptions

► **DIGITIZING**

- Create statistical summaries for preparing map unit description
- Provide for a soil digital thematic layer for GIS

► **FINAL SOIL MAP**



FINAL SOIL MAP

Figure 10. Schematic outline illustrating the soil modeling and mapping process.

Figure 11. Soil pre-map with accompanying polygon symbols based on slope, aspect, photographic interpretation and other resource and supporting data. NW part of Belle Helen, Nevada, quadrangle.

Verify and Edit Soil Pre-Map

The soil pre-map with accompanying draft legend is then reviewed in the field. Soil map unit delineations are verified by observations and soils identified by sampling at selected sites, traverses, and transects. During the field verification, observations and soil sampling are made as necessary to confirm predicted boundaries and soil map unit composition.

The spectral-class map (where applicable) is used during the field verification process to aid in selecting sample sites and identifying spatial and spectral variability within pre-map delineations.

Soil map unit delineations (boundaries) on the soil pre-map are revised, refined, and recorded on the basis of field observations and soil sampling. Soil map unit composition and components are also identified.

If the soil pre-map was digitized before field verification, the accompanying statistical summaries are used to assist in determining soil map unit delineation composition and associated soil setting characteristics.

During field verification and sampling, supporting data including soil pedon descriptions, surface feature descriptions (e.g., vegetation, degree of rockiness, and rock fragment content), and soil performance information are collected. These data are used to support the soil map and to analyze and interpret soil information.

Complete and Digitize Final Soil Map

When field observations and sampling are completed, the work map (draft soil survey field sheet) is given a final edit. This editing process includes: (1) reviewing all delineations to ensure they are closed and all refinements have been recorded, (2) checking the accuracy of all labeling, and (3) final edge-matching with adjacent field sheets. This provides a finished soil map. See Figure 12 for an example of a final soil map showing relationship of boundaries and inclusions with pre-map. If the soil pre-map was digitized, digitizing is then updated to incorporate the changes made on the finished map. If the soil pre-map was not digitized before field verification, the final map is then digitized. Statistical summaries for the final soil map are then produced that associate each delineation number with accompanying legend and related interpretative information.

The digitized final soil map becomes a digital soil data base when incorporated in the GIS that can be used to create thematic maps and to make soil interpretation analyses that are useful in land management.

The SLAP methodology is versatile and can be modified or tailored. Portions or combinations of procedures can be used to meet the specific needs of a soil survey area. See Table 1 for an abbreviated step-by-step procedure for implementing the computer-assisted soil mapping methodology. In addition, detailed procedure information is available in the SLAP training package.

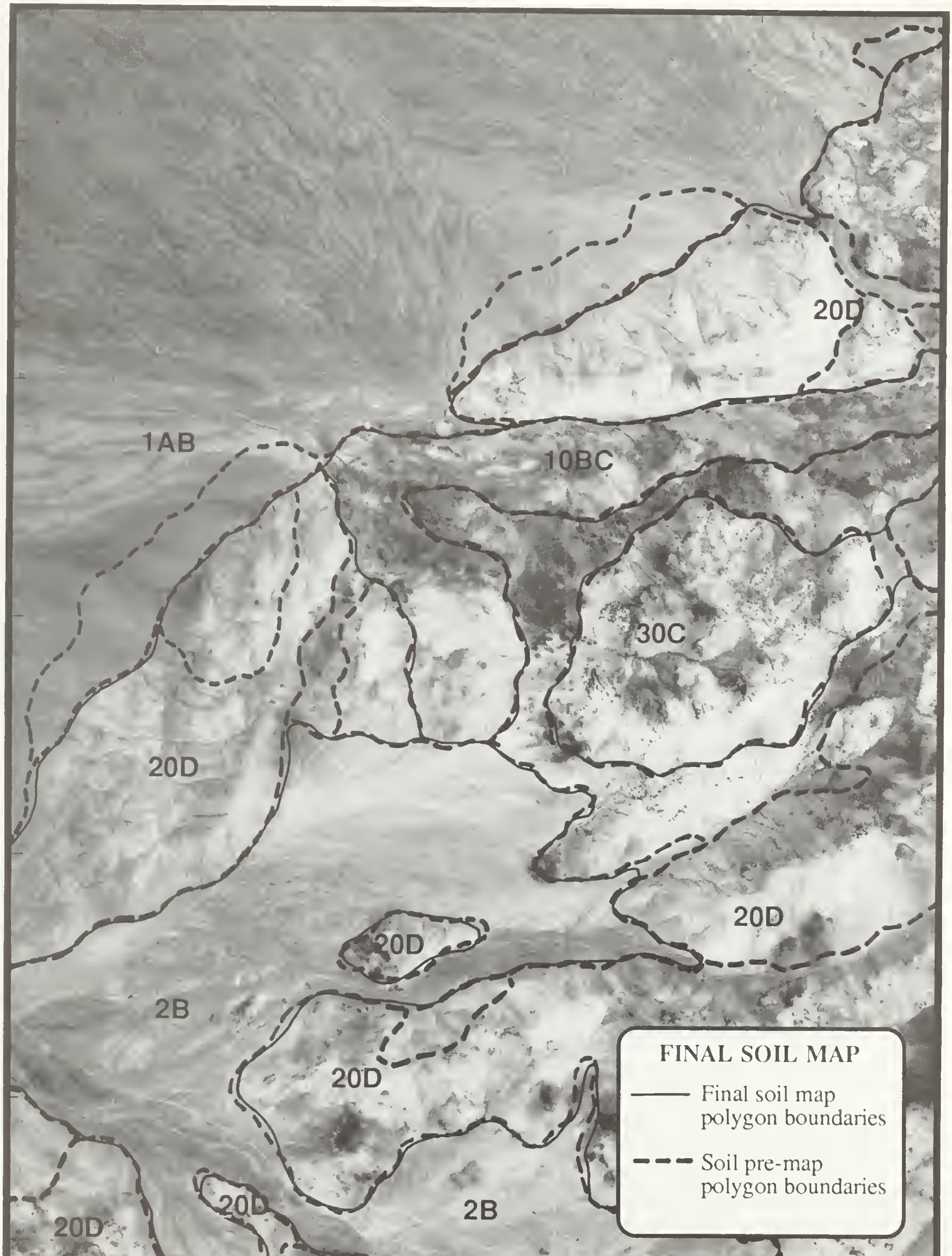


Figure 12. Final soil map showing relationship of boundaries and inclusions with pre-map.

Table 1. General procedures outline for implementing computer-assisted soil mapping methodology.

STEPS	ACTION
1. Collect supporting information. (Essential)	Collect, review, and interpret available supportive information including aerial photographs, geologic maps, existing soil maps, vegetation data, research data, etc.
2. Conduct field reconnaissance. (Essential)	Conduct pre-map field reconnaissance to gain general knowledge and to become familiar with the area. View general features such as soils, geology, vegetation, landform, and land use of the area. Interdisciplinary involvement preferred to assist in map unit design. Use preliminary studies or test mapping of selected areas to develop the following: (1) a perspective of broad patterns of soils, (2) relationship of kinds of soils to landscape and parent material, and (3) relationship of soils and vegetation.
3. Adjust slope-class map. (Essential)	Overlay the computer-generated slope-class map with selected classes identified in color on the USGS quadrangle map to adjust slope-class delineations to fit the contour lines. Then overlay this onto an orthophoto quad to adjust to landforms and to eliminate unnecessary detail. The slope-class polygons created are labeled with slope-class designations. See Figure 9 for example of adjusted slope-class map.

STEPS	ACTION
4. Interpret aspect map. (Optional)	If aspect does not significantly affect soil formation or vegetation due to slope and/or climate, do not use an aspect-class map. If aspect significantly affects soil formation and vegetation and is important in the mapping effort, use aspect-class maps in the following manner: 1. Request an aspect map with selected, identified aspect classes from the host computer. 2. Overlay the aspect map on the adjusted slope-class map and orthophoto quad. Delineate and label additional polygons as needed.
5. Continue soil pre-map preparation. (Essential)	Overlay the adjusted slope-class map and/or aspect-class map on the orthophotograph. Use support information (including climate, geology, vegetation, and existing soils information) and aerial photographic interpretations to refine pre-map delineations and to predict soil types (See Figure 10). (Knowledge of the area is very beneficial at this stage.) Review pre-map to ensure that all polygons are complete, matched, and labeled. The pre-map is now ready to be field verified or digitized. Identify the pre-map information on a mylar overlay or place it directly on an orthophotograph half-tone mylar. See Figure 11 for example of soils pre-map.

STEPS	ACTION
6. Digitize pre-map. **(Optional)**	Soil pre-maps are sent to computer center for digitizing and generating a tabular summary to be used during field verification. Tabular summaries include information specified by field staff. (See discussion in section on products generated from DEM data.) Digitizing may be done only for the final edited map to generate statistical summaries for use in completing soil map unit descriptions and for additional interpretation for soil survey users.
7. Interpret spectral map (Landsat imagery). **(Optional)**	If Landsat data are used to determine inclusions and to aid in soil boundary placements, the following procedure is used. The computer center will create a spectral grouping overlay and accompanying tabular summaries for the field to use to determine inclusions and to aid in refining soil boundary placement or identifying features that may be incorporated into the survey. Additions and revisions are made on the pre-map.
8. Verify pre-map in field) and complete additional soil mapping. **(Essential)**	Verify the soil pre-map by field observations and soil sampling at selected sites. Soil delineations are refined and combined as needed with changes identified on the pre-map. Soil map units are identified. Any additional field mapping is done at this time.

STEPS	ACTION
9. Prepare final soil map. (Essential)	Edit, edge-match, and send the field verified pre-map to the host computer center for digitizing. A final map is created and edited until it is correct and digitized. If the pre-map was digitized before field verification, the host computer will update the digitizing to incorporate changes made to the pre-map during field verification. Prepare tabular summaries for all soil delineations on the final edited map. See Figure 12 for example of final soil map.

REQUIREMENTS TO IMPLEMENT METHODOLOGY

The following materials, computer assistance, staff, training, and cost are required to implement the computer-assisted mapping methodology for soil survey and to generate a digital data base for soil survey and land management.

Materials

- **Supporting Information.** Supporting information (e.g., aerial photography, geology maps, climatic data, vegetation maps, general soils data, research data, and recorded field data) provides soil setting and surface feature information and assists in the soil premapping phase.

- **Orthophotograph Quads.** Orthophotograph quads (Scale 1:24,000) are used as base maps and thus are essential in conducting computer-assisted methodology.

- **USGS Quadrangle Maps.** USGS quadrangle maps are essential tools in conducting soil surveys with SLAP methodology.

- **Digital Elevation Model (DEM) Data.** DEM data are essential to generate graphics displaying slope, aspect, and terrain profiles between selected points. DEM files may be ordered by identifying the quadrangles needed by latitude and longitude of the southeast corner or by quadrangle name.

  The USGS 7.5-minute DEM elevation data format (Scale 1:24,000) with a grid cell size of 30 meters and a vertical resolution of 0 to 7 meters is recommended. Refer to Appendix A for information about the availability of DEM data, DEM products, and ordering procedure.

- **Landsat Imagery** (Optional). The use of Landsat imagery is optional depending on survey area. If Landsat imagery is used, the applications scientist will be responsible for recommending the proper scale and determining quality adequacy. Refer to Appendix A for information on the availability and procedure of ordering Landsat data.

Computer Assistance

The SLAP methodology requires a host computer system capable of processing vector, digital, and raster data. The system also requires the following three modes: data capture and editing, data manipulation and tabulation, and data output. For the Tonopah test, the Automated Digitizing System (ADS) was used to capture and edit map polygons for further Map Overlay and Statistical System (MOSS) analysis processing. BLM utilizes ADS extensively for other GIS efforts.

The processing of DEM data, the capture and editing of soil pre-map data, and the storing and analysis processing of the final soil map data can be accomplished at each BLM State Office and/or at District and Resource Area Offices where the necessary computer equipment is available. All processing of Landsat (CCT) data requires the computer capability currently available at the BLM Service Center or EROS Data Center.

It is recommended that prior to initiating a project using the SLAP procedures, the soil scientist contact the GIS coordinator to detail the logistics of computer support.

Staff

Personnel needed to implement the computer-assisted methodology include field soil scientists and computer applications staff. Field soil scientists are responsible for the complete soil survey procedure consisting of pre-map preparation, field verification and mapping, soil sampling, and recording soil observations. The party leader is responsible for coordinating the pre-map generation, scheduling, and identifying instructions and needs to the host computer applications staff.

The computer applications staff located at the host computer site is responsible for developing the computer-generated maps and tabular summaries as instructed by field soil scientists. The staff manipulate the raw data (DEM and/or Landsat images) into field maps and then generate the tabular summaries. In addition, they are responsible for archiving the vector, raster, and tabular data base when field mapping is complete.

The computer-assisted methodology is most effectively implemented by field staffs that are innovative and multi-resource oriented. Experience within the area to be mapped is also most valuable.

Training

Before starting the computer-assisted procedure, field soil scientists need a clear understanding of the process. The BLM Service Center can provide briefings for field staffs. Subsequent training for field personnel should be considered before implementing the procedure. On-site SLAP training (3 to 5 days) is most effective and can be provided upon request from the BLM Service Center.

A SLAP training package consisting of a slide series, exhibits, and detailed flow charts demonstrating the computer-assisted methodology is available for display and training purposes. Contact the Division of Resources, BLM Service Center for additional information and training needs.

Cost

Costs to implement the computer-assisted methodology will vary by soil survey area based on the need and selection of the most applicable computerized data and products. The cost of data acquisition and processing for the complete computerized methodology is about 3 cents per acre based on the assumption of 36,672 acres per USGS quadrangle. In most cases, the cost per acre would be less than 3 cents, because all DEM and MSS products may not be needed in a soil survey area. Table 2 shows approximate costs of the various products based on the experiences with the Tonopah, Nevada, test and the USGS project on definition of U.S. Geodata products. Costs of the various tasks or data are presented separately so users can determine costs more specifically for selected options.

Table 2. Estimated costs for DEM, Landsat MSS products and digitizing.

ITEM/TASK	COST/QUADRANGLE	COST/ACRE
DEM DATA		
7.5-Minute DEM Data	$ 102.00	$ 0.003
Slope-Class Map	112.00	0.003
Aspect-Class Map	120.00	0.003
Terrain Tabular Summary	41.00	0.001
LANDSAT MSS DATA (OPTIMAL)		
Spectral-Class Map (Quad)	271.00	0.008
Spectral Data Statistical Summary	14.00	< 0.001
DIGITIZING		
Digitize Pre-Map (Optional)	150.00	0.004
Digitize Final Map	150.00	0.004

NOTE: DEM product costs are per quad for 1:24,000-scale maps. Quad costs for spectral data vary depending on the relationship between the size and location of the survey area and Landsat scenes.

The digitizing costs are for Order 3 soil survey and will vary depending on the complexity and number of soil map unit delineations.

CONCLUSIONS

The use of DEM and MSS data alone cannot produce a soil survey. Field observations and soil sampling are still an integral part of the soil mapping process. However, these tools and associated methodology in conjunction with effective use of supportive data by experienced soil scientists will aid in making and updating soil surveys. Just as aerial photographs reduce field time and improve accuracy of soil surveys, the use of computerized technology will also become a valuable tool for soil scientists, other specialists, and resource managers in making and using soil surveys.

By applying the principles and techniques of the SLAP methodology, the inventory specialist can target field efforts and can design and produce soil surveys that are more responsive to the needs of today's users.

GLOSSARY

Air Photo Interpretation: A method of plotting boundaries and estimating composition of delineations based on aerial photographic features that have been related to soils and landscape features. As the term is used here, aerial photographic interpretation includes applicable remote sensing.

Aspect: The horizontal direction in which a slope faces, commonly expressed in degrees clockwise from north. A west-facing slope, for example, would have an aspect of 270 degrees.

Data Base: A collection of interrelated data stored together with controlled redundancy to serve one or more applications. Data are stored so that they are independent of programs that use data. A common and controlled approach is used in adding new data and in modifying or retrieving existing data within a data base. In geographic information systems the collection of data and attributes that are spatially registered to a map base and used to determine data relationships.

Data Flow Diagram (DFD): A picture of data flows through a system of any kind, showing the external entities that are sources or destinations of data, the processes that transform data, and the places where the data are stored.

Digital Elevation Models (DEMs): Digital records of terrain elevations for ground positions at regularly spaced intervals. DEMs are used to generate graphics such as isometric projections displaying slope, direction of slope (aspect), and terrain profiles between designated points.

Digitizing: A process of electronically converting map (or graphics) data into a digital format so the information can be stored in a computer. The process generally records strings of x,y coordinates and thematic information for subsequent storage.

Extrapolation: The estimation of surface values or other attributes in areas beyond those with data.

Geographic Information System: An information system that can input, manipulate, and analyze geographically referenced data in order to support the decisionmaking processes of an organization.

Interpolation: The estimation of surface values in areas with data values nearby, on more than one side.

Observation: Visual checking of landscape features, exposed geological formations, or exposures of pedons from within or outside a delineation to project boundaries and composition from previously determined relations; aerial photographs may be used as guides. This is a less intensive operation than traversing.

Overlay: The superimposition of one map or digital image over another of the same area in order to determine data combinations or intersections and unions.

Pedon: (As used in Soil Taxonomy, a classification system of the National Cooperative Soil Survey in the United States): A three-dimensional soil profile with lateral dimensions large enough to permit the study of horizon shapes and relations; the smallest volume that can be called "a soil." It has three dimensions: it extends downward to the depth of plant roots or to the lower limit of the genetic soil horizons; its lateral cross section is roughly hexagonal and ranges from 1 to 10 square meters in size depending on the variability in the horizons.

Polygon: Plane figure consisting of three or more vertices (points) connected by line segments of sides.

Process (Transform, Transformation): A set of operations transforming data, logically or physically, according to some process logic.

Raster Data: A form of digital data that portrays a map in terms of cells or grids, usually according to major themes or attributes.

Soil Delineation: A selected and differentiated portion of a landscape that contains a unique composition and pattern of soils and is identified by a map boundary. The boundary of a delineation can be placed at the boundary of a polypedon identified by use of soil series-level differentia, or at the boundary of a polypedon or contiguous polypedons identified by use of soil-family (or higher) level differentia, or at the boundary of a landscape unit containing a describable pattern of soils or land types described at any categorical level.

Soil Map: A map showing the distribution of soil types or other soil mapping units in relation to the prominent physical and cultural features of the earth's surface. The following kinds of soil maps are recognized in the United States: detailed, detailed reconnaissance, reconnaissance, generalized, and schematic.

Soil Mapping Unit: A kind of soil or miscellaneous area or a combination of soils or of soil(s) and miscellaneous area(s) that can be shown at the scale of mapping for the defined purposes and objectives of the survey. (Combination of kinds of soil includes soil association, complexes, undifferentiated soils, or any class or combination of classes at the family level or higher categories of the soil classification system.) Soil mapping units are the basis for the delineations of a soil survey map. The map unit description identifies the soil components, proportions, and landscape pattern of occurrence. Mapping units normally contain inclusions of soils outside the limits of the taxonomic name or names used as the name for the mapping unit.

Soil Sampling: The process of taking physical samples from pedons or selected horizons for field analysis or for later laboratory analysis.

Spectral Data: A remote sensing term whereby geographic data are collected based on the wavelength, frequency, or wave numbers of light.

Stereoscopy: The science that deals with stereoscopic effects and methods. That mental impression of a three-dimensional object that results from stereoscopic vision (stereo-viewing).

Transect: The field procedure of crossing delineations or landscape units along selected lines to determine the pattern of polypedons with respect to landforms, geologic formations, or other observable features. Visible or simply determinable features that are related to soils and soil occurrence can be predicted locally from these features.

Traverse: Validation of the predicted boundaries or composition of a delineation by entering it or crossing it and identifying pedons at selected or random positions. A traverse requires that the significant horizons of each soil component in a delineation be examined physically by shovel or auger. For Order 3 surveys, the location of the examination should be shown by a symbol within the delineation drawn on the field sheet and keyed to field notes if notes are made. If all component soils of a delineation are not examined or the examination site is not located by a symbol, the mapping operation shall be considered an "observation." Air photo interpretation is used during traversing.

Vector Data: A form of digital data comprising x,y coordinate representations that are portrayed by points, lines (strings of points), or polygons (closed lines).

Working Map: Base maps used to record soil survey information and other data important to the conduct of a soil survey prior to map compilation and finishing (Draft Soil Survey Field Sheet).

ACRONYMS AND ABBREVIATIONS

ADS - Automated Digitizing System

BLM - U.S. Department of Interior, Bureau of Land Management

DEM - Digital Elevation Model

EROS - Earth Resources Observation System

GIS - Geographic Information System

DIMS - Interactive Digital Image Processing System

MOSS - Map Overlay and Statistical System

MSS - Multispectral Scanner (Landsat)

NCSS - National Cooperative Soil Survey

SCS - U.S. Department of Agriculture, Soil Conservation Service

SLAP - Soil Landscape Application Project

USGS - U.S. Department of the Interior, Geological Survey

BIBLIOGRAPHY

Cooke and Doornikamp. 1974. Geomorphology in environmental management. Claredon Press-Oxford University Press. Great Britain.

Elassal, Atef A. and Vincent M. Caruso. 1983. Digital elevation models. U.S. Geological Survey Circular 895-B. United States Government Printing Office.

Foster, John W. and Alan Amen. 1986. The Soil Landscape Analysis Project (SLAP) methodology evaluation of the Tonopah, Nevada, pilot test. Proceedings of Geographic Information Systems Workshop, April 1-4, 1986. pp. 378-383.

Horvath, E.H. and E.A. Fosnight. 1985. Sequence of computer operations for the soil landscape analysis project methodologies. BLM Service Center, Denver, CO.

Horvath, E.H.; E.A. Fosnight; A.A. Klingebiel; D.C. Moore; and J. Stone. 1985. Using a spatial and tabular data base to generate statistics from terrain and spectral data for soil surveys. 49th Annual Meeting of the Soil Science Society of America.

Horvath, E.H.; A.A. Klingebiel; D.G. Moore; and E.A. Fosnight. 1983. Alternate data sources for soil surveys on rangeland. U.S. Geological Survey Open-File Report 83-880.

Klingebiel, A.A.; E.H. Horvath; D.G. Moore; and W.U. Reybold. 1985. Use of slope, aspect, and elevation maps derived from digital elevation data in making soil surveys. Soil Science Society of America, Soil Survey Symposium. In press.

Loveland, T.R. and B. Ramey. 1986. Applications of U.S. Geological Survey digital cartographic products, 1979-1983. U.S. Geological Survey Bulletin 1583.

Miller, Fred P.; Donald E. McCormack; and James R. Talbot. 1979. Soil surveys: review of data-collection methodologies, confidence limits and uses. Transportation Research Record 733.

Peterson, Fredrick F. 1981. Landforms of the basin and range province--defined for soil survey. Technical Bulletin 28. Nevada Agricultural Experiment Station, University of Nevada, Reno.

Shovic, H.F. and C. Montagne. 1985. Application of a statistical soil-landscape model to an Order II wildland soil survey. Soil Sci. Soc. Am. J. 49:961-968.

U.S. Department of Agriculture, Soil Conservation Service. 1976. National Cooperative Soil Survey Handbook. Washington, DC.

U.S. Department of Agriculture, Soil Conservation Service. 1980. Soil Survey Manual. Chapter 3, Preparing for Mapping. Washington, DC.

U.S. Department of Agriculture, Soil Conservation Service. 1986. Soil survey work group functional specifications prepared by soil survey work group.

U.S. Department of Interior, Bureau of Land Management. 1983. The use of remote sensing for soil investigations on BLM lands. Technical Note 361. BLM Service Center. Denver, CO.

U.S. Department of Interior, Bureau of Land Management. 1986. Evaluation of the soil landscape analysis project (SLAP) methodology in Tonopah, Nevada. Internal Final Report for RDTS #7312.003.

U.S. Department of Interior, Geological Survey. 1986. Final report: definition of U.S. geodata products for use in soil surveys. EROS Data Center in cooperation with the Soil Conservation Service. (in press)

U.S. Department of Interior, Geological Survey. 1987. A guide for the use of digital elevation model data in making soil surveys. U.S. Geological Survey Open-File Report. National Mapping Division, EROS Data Center in cooperation with USDA, Soil Conservation Service and Forest Service and USDI, Bureau of Land Management. (in press)

Weismiller, R.A. and S.A. Kaminsky. 1978. Application of remote sensing technology to soil survey research. Journal of Soil and Water Conservation. November-December 1978. pp. 287-289.

APPENDIX A - INFORMATION ON ORDERING DEM DATA AND LANDSAT DATA

DEM Data

Availability

DEM data are not available for all areas. However, completed 7.5-minute DEMs are being added to the data base daily. A status graphic depicting the current availability of 7.5-minute DEMs is produced by the National Cartographic Information System Center. BLM is also initiating a program to maintain current listings of USGS and BLM DEM holdings available to users. Reference is made to BLM Information Bulletin No. DSC-87-62; February 4, 1987; Subject: Digital Evaluation Model (DEM) Library.

> In an effort to maintain the integrity of the Bureau's DEM Repository, we request that any current or future DEM orders with USGS be coordinated through the Service Center. DEM orders routed through the Service Center are filed in the Bureau's Repository and the original type then forwarded to the requester.
>
> . . . field offices check the Service Center's Repository for availability before ordering from USGS. The Repository also contains a limited number of Digital Line Graphs (LDGs) and Defense Mapping Agency (DMA) tapes. The Service Center's holdings for these files will be furnished as requested.
>
> The Service Center is currently evaluating several methods (electronic mail, floppy disk, hard copy, ASPEN) of making current listings of USGS and Bureau DEM/DLG/DMA holdings available to the user. . . . .

Where DEM data are not available, reference is made to BLM Instruction Memorandum No. DSC-87-64; January 13, 1987; Subject: Orthophoto Digital Elevation Model Information.

> Recently, the Bureau entered the agreements with the United States Geological Survey (USGS) concerning the production of orthophotoquads (OPQs) and Digital Elevation Models (DEMs). Essentially, these agreements enhance DEM/OPQ availability in areas managed by the Bureau. These products will be produced by the Bureau for input into the National Cartographic Information Center (NCIC) Data Base.
>
> Product priorities will be coordinated through the Service Center and USGS Rocky Mountain Mapping Center. State Office needs should be identified (delineated on 7.5-minute USGS indexes) to the Service Center (D-436) at least 120 days prior to need.

The State Offices should be prepared to provide the following funding to cover the Bureau's production cost:

1:24,000 OPQ. $125.00
1:24,000 DEM. . . . . $ 75.00*

Digital Elevation Models and Orthophotos at a scale other than 1:24,000 are also available. Cost estimates will be provided on these products as they are identified to the Service Center. Questions about the above should be directed to (D-436) FTS 776-0171.

*The Digital Elevation Model agreement with USGS is that for every Bureau-produced DEM, USGS will provide the Bureau with a DEM from the NCIC Data Base (two DEMs for $75.00).

Ordering DEM Products

To order DEM products the soil survey party would identify the area of quadrangle coverage, kind of product, and product specification. This information would be forwarded to the appropriate State Office Soil Program Coordinator.

Descriptions and specifications of DEM products are included in the USGS Circular, Definitions of U.S. Geodata Products for Use in Soil Surveys, that is currently in press. Draft copies are available from the BLM Service Center; Division of Resources (D-470); Box 25047; Denver, CO 80225-0047; FTS 766-0154 or Commercial (303) 236-0154. See DEM-Derived Products Order Form.

The following forms are recommended formats to be used when ordering DEM products for use in soil mapping. These forms are from the publication, Definition of U.S. Geodata Products for Use in Soil Surveys (USGS 1986).

DEM-DERIVED PRODUCTS
ORDER FORM

Name: ____________________________________

Mailing Address: ____________________________________

____

____

Telephone: ____________________________________

List of Quadrangles

Please Check Required Products

Quadrangle Name	Slope Class	Aspect Class	Elevation Class	Slope Polygon & Tabular Summary

Product Specifications

Slope-Class Maps

A. Slope-Class Intervals

	Start		End
Class 1:	________%	-	________%
Class 2:	________%	-	________%
Class 3:	________%	-	________%
Class 4:	________%	-	________%
Class 5:	________%	-	________%
Class 6:	________%	-	________%
Class 7:	________%	-	________%
Class 8:	________%	-	________%

B. Color Scheme (check one):

Continuous Hue ______
Discrete Colors ______

Aspect-Class Maps

A. Aspect-Class Intervals (compass degrees):

	Name	Start		End
Class 1:	________	________	-	________
Class 2:	________	________	-	________
Class 3:	________	________	-	________
Class 4:	________	________	-	________

B. Low-Slope Mask

- Please provide the percent slope value that should be used to mask level-terrain aspect.
  ________% (15% will be used if no value is given.)

C. Color Scheme (check one):

Continuous Hue ______
Discrete Colors ______

Elevation Class

A. Elevation-Class Interval

	Start		End
Class 1:	________Ft.	-	________Ft.
Class 2:	________Ft.	-	________Ft.
Class 3:	________Ft.	-	________Ft.
Class 4:	________Ft.	-	________Ft.

B. Elevation lines superimposed on (check one)

1. Slope class map ________
2. Aspect class map ________

Landsat Data

Availability

A variety of photo reproductions of Landsat imagery and computer-compatible tapes of scenes are available for all areas.

Ordering Landsat Products

Both images and computer tapes may be ordered from USGS's EROS Data Center. EROS Data Center serves as a broker between U.S. Government agencies and the private company that currently operates and distributes Landsat data under government contract. When ordering data, it is important to provide the geographic coordinates or a map marked with the specific area. When ordering, use the Landsat products order form and the selected coverage order form with map. To contact the EROS Data Center, send correspondence to U.S. Geological Survey; EROS Data Center; Sioux Falls, SD 57198; or phone Commercial (605) 594-6507 or FTS 784-7507. The Branch of Remote Sensing (D-473) at the BLM Service Center is also available to advise and assist field offices. To contact D-473, phone (303) 236-6376 or FTS 776-6376.

50272-101

REPORT DOCUMENTATION PAGE	1. REPORT NO. BLM/YA/PT-87/016+7000	2.	3. Recipient's Accession No.

4. Title and Subtitle
The Use of Soil Landscape Analysis Project (SLAP) Methods in Soil Surveys

5. Report Date
August 1987

6.

7. Author(s)
U.S. Department of the Interior, Bureau of Land Management

8. Performing Organization Rept. No.
TN 379

9. Performing Organization Name and Address
U.S. Department of the Interior
Bureau of Land Management Service Center
P.O. Box 25047
Denver, CO 80225-0047

10. Project/Task/Work Unit No.

11. Contract(C) or Grant(G) No.
(C)
(G)

12. Sponsoring Organization Name and Address
U.S. Department of the Interior
BLM Service Center
P.O. Box 25047
Denver, CO 80225-0047

13. Type of Report & Period Covered

14.

15. Supplementary Notes

16. Abstract (Limit: 200 words)

This technical note describes the Soil Landscape Analysis Project (SLAP) methodology for making Order 3 soil surveys and for supplementing and updating existing soil surveys.

SLAP methodology incorporates Geographic Information System (GIS) technology, Digital Elevation Model (DEM) data, and Landsat Multispectral Scanner (MSS) and/or Landsat Thermal Mapping (TM) data with the soil mapping process to create pre-maps and final soil maps with a digital data base. The process permits the use of GIS for edge matching soil polygons, calculating area, manipulating tabular data, and generating thematic maps. SLAP methodology can be used to make new soil surveys, supplement and update existing soil surveys, and extrapolate sample site information to larger areas.

17. Document Analysis a. Descriptors

Soil surveys	0807	0813
Soil analysis	0813	0807
Mapping	0802	

b. Identifiers/Open-Ended Terms

Soil Landscape Analysis Project
SLAP

c. COSATI Field/Group

18. Availability Statement	19. Security Class (This Report)	21. No. of Pages
Release Unlimited	Unclassified	45
	20. Security Class (This Page) Unclassified	22. Price

(See ANSI-Z39.18) See Instructions on Reverse OPTIONAL FORM 272 (4-77) (Formerly NTIS-35) Department of Commerce

U.S. GOVERNMENT PRINTING OFFICE: 1987—773-003/60,826 REGION NO 8